A COOPERATIVE STUDY OF THE ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM AND THE SAN JOAQUIN COUNTY AGRICULTURAL COMMISSIONER TO DETERMINE THE USEFULNESS OF GRAPE PLANTS AS BIOMONITORS FOR 2,4-D

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STATE OF CALIFORNIA
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By

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ABSTRACT

Injury to non-target crops after application of 2,4-D to target crops is a continuing problem in California. Grape vineyards in the Lodi area of San Joaquin County have exhibited 2,4-D-like symptoms periodically in the spring, presumably as the result of drift from 2,4-D application to other crops.

Past studies using traditional air monitoring equipment were expensive and did not successfully identify the source of 2,4-D-like symptoms occurring on non-target crops. Therefore, an inexpensive biomonitoring grid using grape plants was established in San Joaquin County in an attempt to indicate off-target movement of 2,4-D. The results from the first year's operation of the biomonitoring grid showed it was logistically possible to establish grape cuttings and maintain healthy plants for the purpose of monitoring for 2,4-D. The cost of establishing and maintaining the ten square mile grid from February through June was approximately $3,000. Although a complete assessment of the usefulness of the biomonitoring grid was limited because few 2,4-D-type symptoms occurred in the county, the county plans to continue the grid for the foreseeable future. If widespread 2,4-D-like symptoms occur again, the grid may help identify the source of the symptoms and lead to a possible solution to the problem.

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GRAPE PLANTS AS BIOMONITORS FOR HERBICIDE 2,4-D

INTRODUCTION

The herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) is commonly used to control broadleaf weeds in many crops in California. Although the compound is effective and relatively inexpensive, it is frequently implicated as the cause of injury to grapes in the Lodi area of California (Kasimatis et. al., 1968). Several thousand acres of corn are annually planted in the western part of San Joaquin County and eastern Sacramento County where 2,4-D is applied during May and June of each year. In the eastern part of San Joaquin County (Lodi area), there are almost 15,000 acres of grape vineyards, parts of which periodically experience leaf injury similar to that caused by 2,4-D.

The Environmental Hazards Assessment Program (EHAP) conducted a study in Contra Costa and San Joaquin Counties in 1979 to determine if there was a relationship between concentrations of 2,4-D in the air and injury to grape leaves (Neher, et al., 1979). No. 2,4-D was detected in samples collected by low volume air samplers (MDL= 1 ug for ester forms and 2 ug for amine forms). Coincidentally, no grape injury was reported during the 1979 growing season.

A possible alternative to electrical and mechanical air sampling is the use of grape plants (Vitis vinifera) as biomonitors for 2,4-D. Grape plants have been used as biomonitors for air pollutants (Feder and Manning, 1979). A literature search did not reveal any studies that used grape plants as biomonitors for pesticide drift. Grape plant biomonitors may be more sensitive for detecting low concentrations of 2,4-D and much less expensive to use compared to air samplers. Kasimatis et. al., showed that 0.0001 ug of 2,4-D applied in drops of 50% ethyl alcohol to expanding Tokay grape leaves caused 2,4-D-like injury.

However, the relationship between 2,4-D exposure through drops placed on leaves and exposure through the air and the resulting injury is unknown. This report discusses a study to initiate a biomonitoring grid and assess the usefulness of grape cuttings as biomonitors for 2,4-D in San Joaquin County.

MATERIALS AND METHODS

Grid Location

The San Joaquin County Agricultural Commissioner's (SJAC) staff provided information on cropping patterns and developed a map to delineate the distribution of corn and grape acreage in the county. A grid (Figure 1) of approximately 10 square miles was chosen after development of the cropping map. The grid was placed downwind of the corn acreage and upwind of the grape acreage under the prevailing wind conditions of May and June. Prevailing wind direction is northwesterly.

Site Locations

SJAC staff, in consultation with EHAP, selected the actual planting sites within the 10 square mile grid (Figure 1). Ninety-six planting sites were selected according to the criteria listed in Table 1. The county obtained land owner's permission for using each site.

Planting

County personnel and grape growers planted three rooted cuttings of *V. vinifera* (Tokay) at each site during February, 1987. Cuttings were grown in one gallon peat pots and were imported from an area approximately five miles east of Lodi with a low probability of exposure to 2,4-D. Cuttings were randomly selected and assigned to planting sites before planting. One-hundred cuttings were

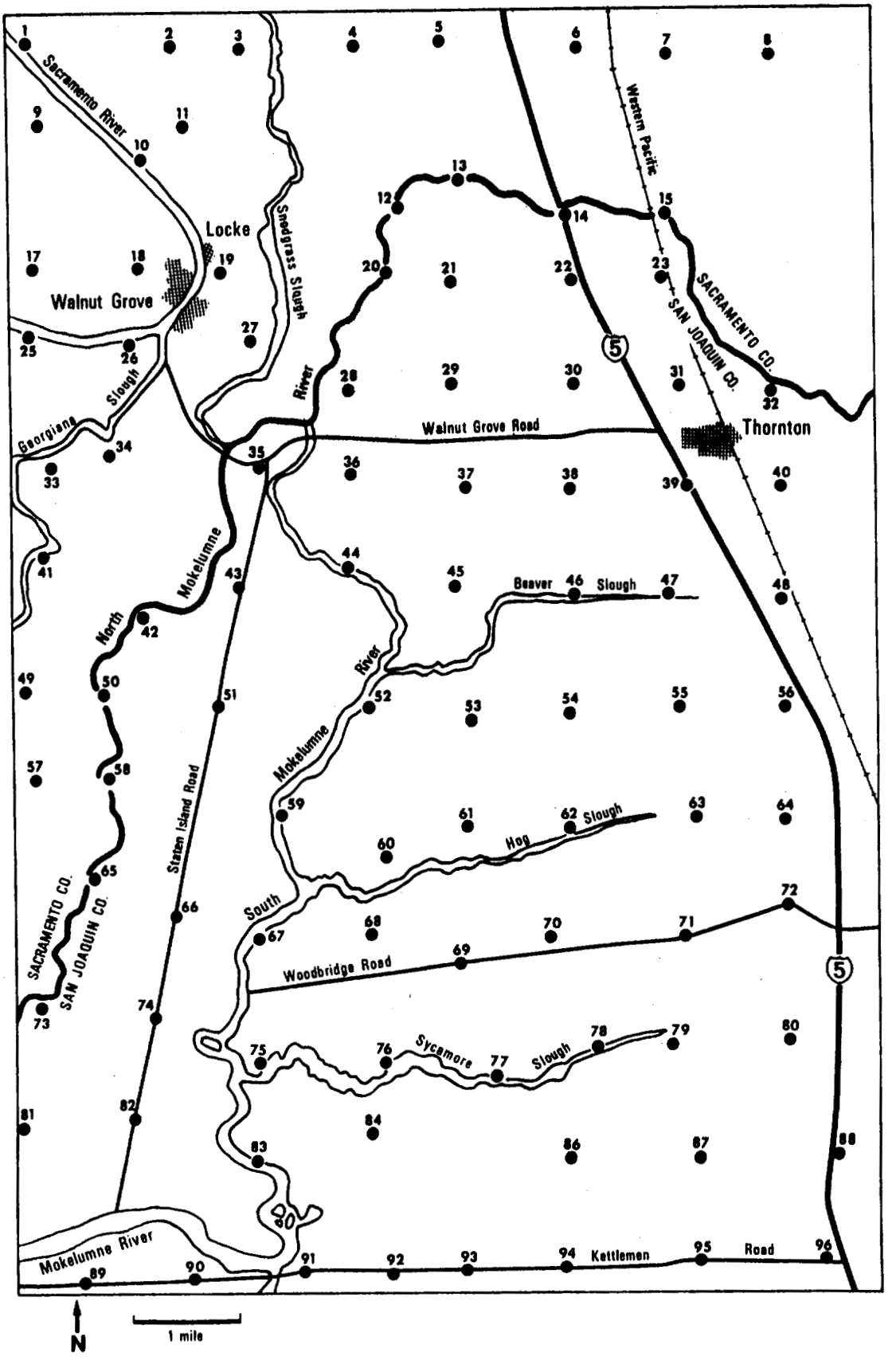


Figure 1. Site locations of Biomonitoring Grid in San Joaquin and Sacramento Counties.

Table 1. Criteria for Selecting Planting Sites for Grape Biomonitoring Network.

1. A site should be within .5 - 1.5 miles of adjacent sites (sites should be approximately 1 mile apart).

2. Sites must be accessible from road.

3. Sites must be located so that they are exposed to prevailing winds (free from building, blocking levee).

4. Yet, sites must be protected from farm machinery and adverse agricultural practices.

5. Each site's distance from crossroads should be known (odometer readings).

maintained and held in reserve as replacement plants during the monitoring period (May and June).

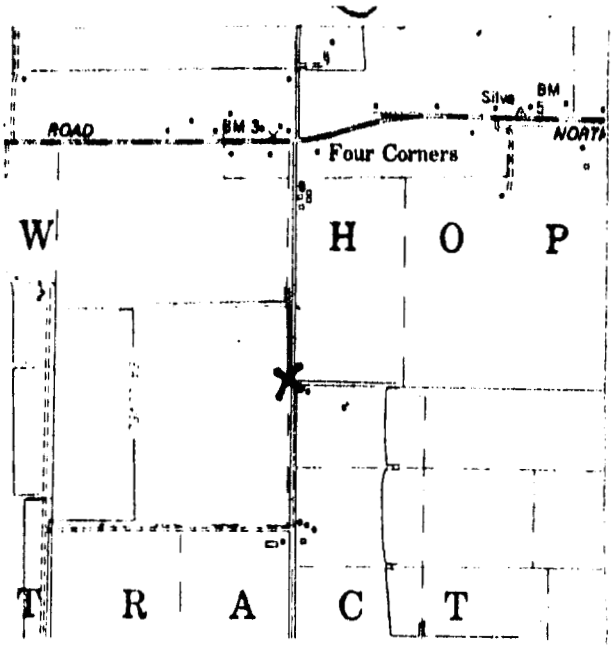
Maintenance and Monitoring

Plants were watered and maintained as needed to insure normal vegetative growth. Most 2,4-D herbicide applications to corn acreage in the county occur in May and June. Therefore, each site was visited weekly during May and June to maintain plants and record data on data forms (Figure 2). Information on symptom rating and any other observations were recorded. A scale of 1-5 was used to rate the plants for 2,4-D leaf injury (1= 0-20%; 2= 21-40%; 3= 41-60%; 4= 61-80%;and 5= 81-100% of total leaf area affected per plant).

RESULTS AND DISCUSSION

The objective of this study was to initiate a biomonitoring grid and determine the usefulness of grape plants as biomonitors to detect 2,4-D in San Joaquin County. The original intent was to compare information on 2,4-D applications in the county during May and June with grape leaf injury data collected from the monitoring sites. Theoretically, a trail of injury would indicate a probable source based on prevailing wind direction. This comparison was not very meaningful during 1987 because only two sites showed 2,4-D symptoms and the source of the 2,4-D was known. No other incidences of 2,4-D injury on grapes in the Lodi area were reported. Therefore, this study was unable to determine if a grape biomonitoring grid could help locate sources of 2,4-D herbicide when 2,4-D-like injury on grapes was reported.

One possible reason for the lack of injury data was the presence of the biomonitoring network. The purpose of the network was well known by local growers who use 2,4-D. Some growers may have used extra caution when applying 2,4-D or used alternate materials to avoid 2,4-D injury to non-target crops such



GRAPE BIOMONITORING

SITE NUMBER 38

Other Observations

ST - Sample taken
MD - Mechanical Damages
I - Insect Damage
SM - Site Missing
CD - Chemical Damage other than Phenoxy/Dicamba

Symptom Rating

1:	0 - 20%	4:	61 - 80%
2:	21 - 40%	5:	81 -100%
3:	41 - 60%		

Inspected By	Date Watered.	Cane Length in inches	Leaf Count	Replacement Vine	Sympton Rating	Inspector Recheck Needed	Other Observation

Figure 2. Form Used to Collect Data From Each Biomonitoring Site.

as grapes. For example, 10,700 acres of corn were treated with 2,4-D in 1986, but only 4,000 acres were treated in 1987.

Previous EHAP studies indicated that fewer incidences of 2,4-D injury on non-target crops may occur when a study is in progress. A study (Neher, et al., 1979) conducted by EHAP in 1979 in San Joaquin County reported no detection of 2,4-D in air samples, and no incidences of 2,4-D injury to grapes during that growing season. The authors indicated that the results of the study may be attributed to unique weather conditions during the growing season, but resources were not available to demonstrate a relationship to weather conditions. The number of acres treated with 2,4-D during 1979 was similar to the number of acres treated during previous seasons.

Another air monitoring study (Simpson, et al., 1981) conducted by EHAP in 1980 to determine the presence of 2,4-D in Kern, Kings and San Luis Obispo Counties did not detect any drift from San Luis Obispo County in the San Joaquin Valley. Cooler weather conditions and a 30% reduction in the number of acres treated with 2,4-D during 1980 compared with the previous season may have accounted for the study results. Increased grower and applicator caution when using 2,4-D or the use of alternative herbicides may also have helped to account for the lack of injury observed in both of the above studies.

Increased caution by growers and applicators may not fully explain the lack of 2,4-D-like symptoms in San Joaquin County during the course of the study. The typical pattern of 2,4-D-like symptoms occurring in grapes in the Lodi area over the past 35 years has been characterized by a one or two year duration of widespread symptoms followed by a disappearance of symptoms for some indeterminate number of years before symptoms reappear (personal communication, Erwin Eby, San Joaquin County Agricultural Commissioner). Exhaustive

investigations by county staff have been unable to find evidence that illegal or imprudent 2,4-D applications explain the widespread symptoms found in the area.

Several factors could affect the ability of a grape biomonitoring network to detect 2,4-D drift. One factor could be plant health. Plants in good condition could express a different response to 2,4-D than plants in poor condition. During the month of May and June, when the plants were checked for symptoms, the plants were in good condition and their reaction to 2,4-D should have been similar to plants in vineyards. Another factor would be the ability of personnel to observe 2,4-D-like symptoms. Kasimatis et. al., assert that identification of 2,4-D-like symptoms in the field is readily made by experienced personnel. San Joaquin County personnel are experienced in identifying 2,4-D-like symptoms. A third factor might be the qualitative nature of the data provided by a biomonitoring network. This factor is difficult to assess because the biomonitoring network provided no data during the first growing season.

The cost of using grape plants as biomonitors for 2,4-D was only a fraction of standard air sampling and chemical analysis procedures. To monitor the ten square mile area used in the present study with air sampling equipment would be extremely costly. The air sampling equipment for 90 sites would cost in excess of $100,0000. Chemical analysis for 2,4-D at 90 sites with samples averaged over 24 hours for 60 days would cost over $500,000. The maintenance of such an air monitoring effort would also be very costly. In contrast, the cost of planting, maintaining and monitoring the grape biomonitoring network was slightly under $3,000 (Table 2).

Biomonitoring networks may have potential to be sensitive detectors of 2,4-D and provide qualitative information for little cost. This potential remains to be

Table 2. Estimated Time and Cost Expended by Participants on the Grape Biomonitoring Study in San Joaquin County[a].

Task		Time (hrs)	Approximate Cost ($7.00/hr charged)
I.	Preplant	50	$ 350.00
	a. planning meetings b. grower contact c. finding possible location		
II.	Planting	100	700.00
	a. preparing maps of locations b. planting		
III.	Monitoring Activities	200	1,400.00
	a. checking for symptoms b. replacing injured plants		
IV.	Maintenance Activities	75	525.00
	a. watering b. weed control c. pruning		
v.	Vehicle & Other Equipment		
		TOTAL	$2,975.00

[a]Vehicle costs are not included in the estimates.

demonstrated. Air monitoring equipment may provide quantitative information on 2,4-D but at relatively high cost. Other counties with problems similar to San Joaquin County should consider the applicability of a biomonitoring approach to assess their particular problem as an alternative to expensive air monitoring equipment.

San Joaquin County plans to continue the biomonitoring network for the foreseeable future. If widespread 2,4-D-like symptoms appear again in the Lodi area, the biomonitoring network may be able to help identify the source of the symptoms and lead to a possible solution to the problem.

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